Return loss and coupling attenuation: key parameters for 100BASE-T1L; IL proposal for building automation

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Agenda

- Return loss and why it is important
- Return loss for a link
- Return loss for a connector
- Common mode suppression
- Discussions about building automation
- Insertion loss proposals
- Alien crosstalk
- Questions from graber_3dg_01_08302022

For graphical representation a maximum upper frequency of 100MHz was chosen for 100Base-T1L, the maximum upper frequency might be lower depending on the modulation scheme.

Return loss and why it is important

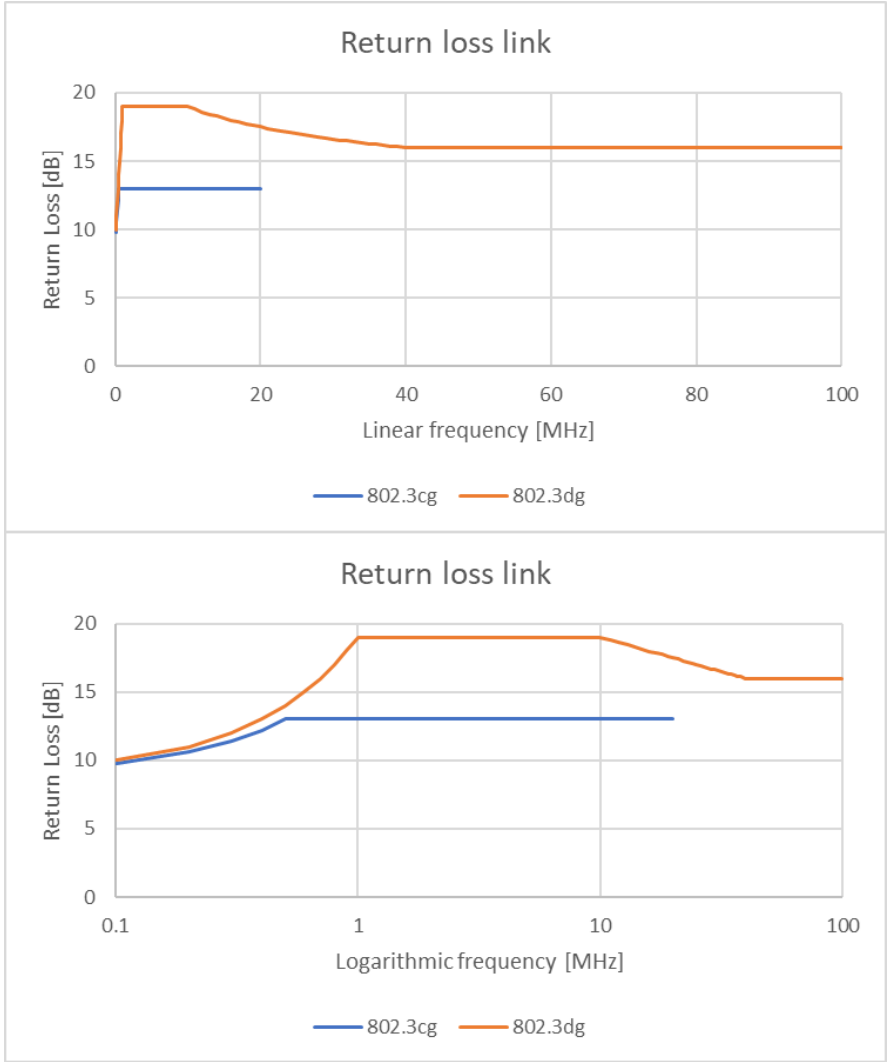
- Return loss is the loudest noise in any link
- Return loss is the only parameter we can apply echo cancelling (EC) for single pair ethernet
- The better return loss is, the less compensation is needed to achieve the same final noise level. This leads to faster correction and less power consumption.

→ Higher return loss requirements pay back twice: During the development of a less complicated EC and during operation by utilizing less power and less time as less bits are required for the EC.

Return loss for a link

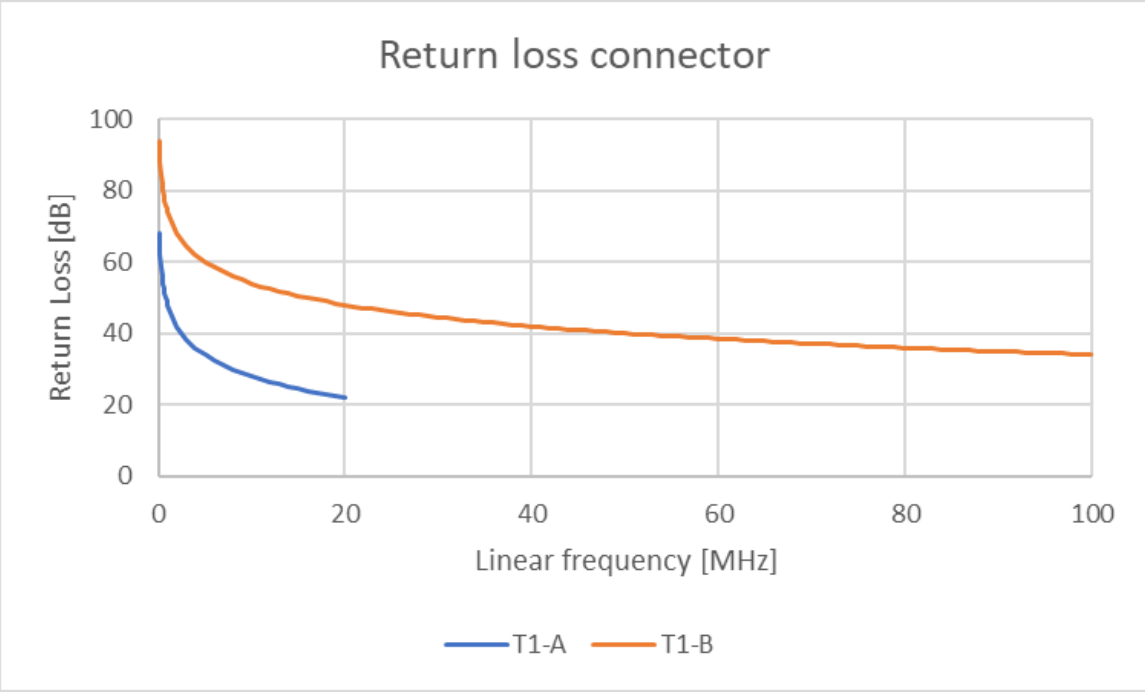
Return loss of a link is defined in IEEE 802.3cg
10Base-T1L (blue line):
0.1 - 0.5MHz: 9+8*log(f) [dB]
0.5 - 20MHz: 13 [dB]

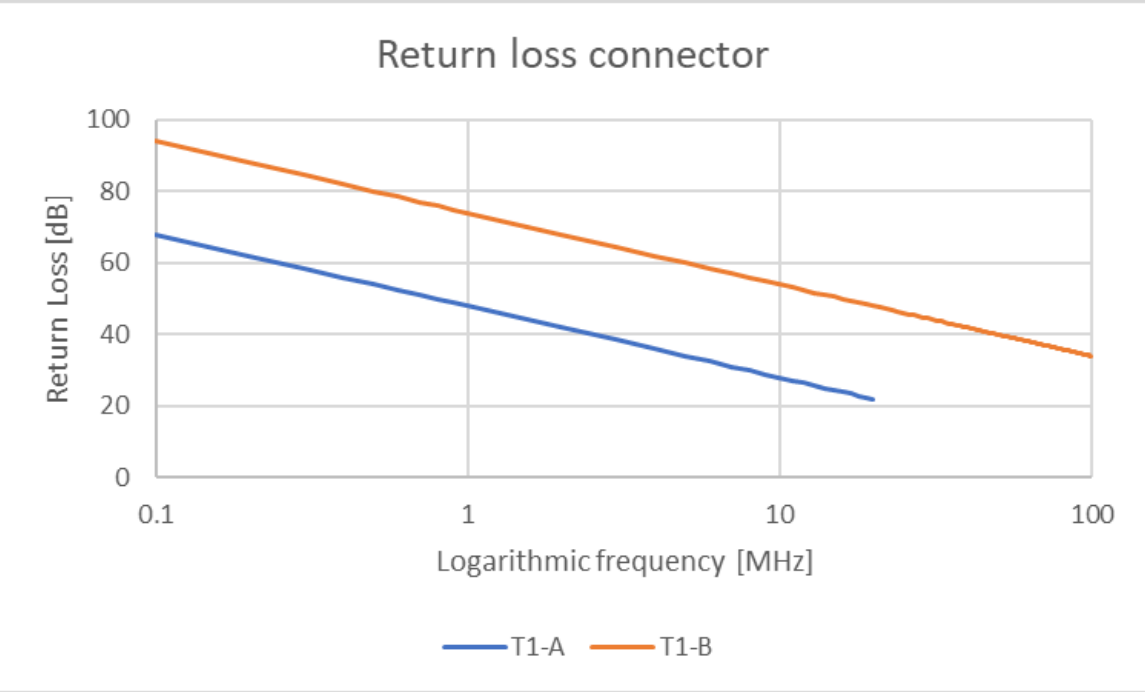
Return loss proposal of a link for 802.3dg
100Base-T1L (red line):
0.1 – 1MHz: 9+10*log(f) [dB]
1 – 10MHz: 19 [dB]
10 – 40MHz: 24-5*log(f) [dB]
40 – 100MHz: 16 [dB]



Return loss for a connector

Return loss of a T1-A connector, which supports IEEE 802.3cg 10Base-T1L (blue line):
0.1 - 20MHz: 48-20*log(f) [dB]
Proposal for 802.3dg 100Base-T1L (red line):
0.1 – 100MHz: 74-20*log(f) [dB]





Note: Plateaus not included in limit lines to show connector possibilities

Return loss and why it is important

- Return loss is the loudest noise in any link → improve return loss by up to 6dB for the link
- Proposal to improve the connector return loss by 26dB by using an impedance-controlled connector
  - 26 dB are IEC values
- Connectors are already defined in the IEC 63171-x series, cables which are needed to build such a link are defined in IEC 61156-11/-12

Common mode suppression

IEEE 802.3cg 10Base-T1L defines TCL up to E2, a level of 44 dB@20 MHz

Table 146–5—Differential to common mode conversion

	Frequency (MHz)	E_1	E_2
TCL	$0.1 \le f \le 10$	≥ 50 dB	≥ 50 dB
TCL	$10 < f \le 20$	$\ge 50 - 20\log_{10}\left(\frac{f}{10}\right)$ dB	$\ge 50 - 20\log_{10}\left(\frac{f}{10}\right)$ dB

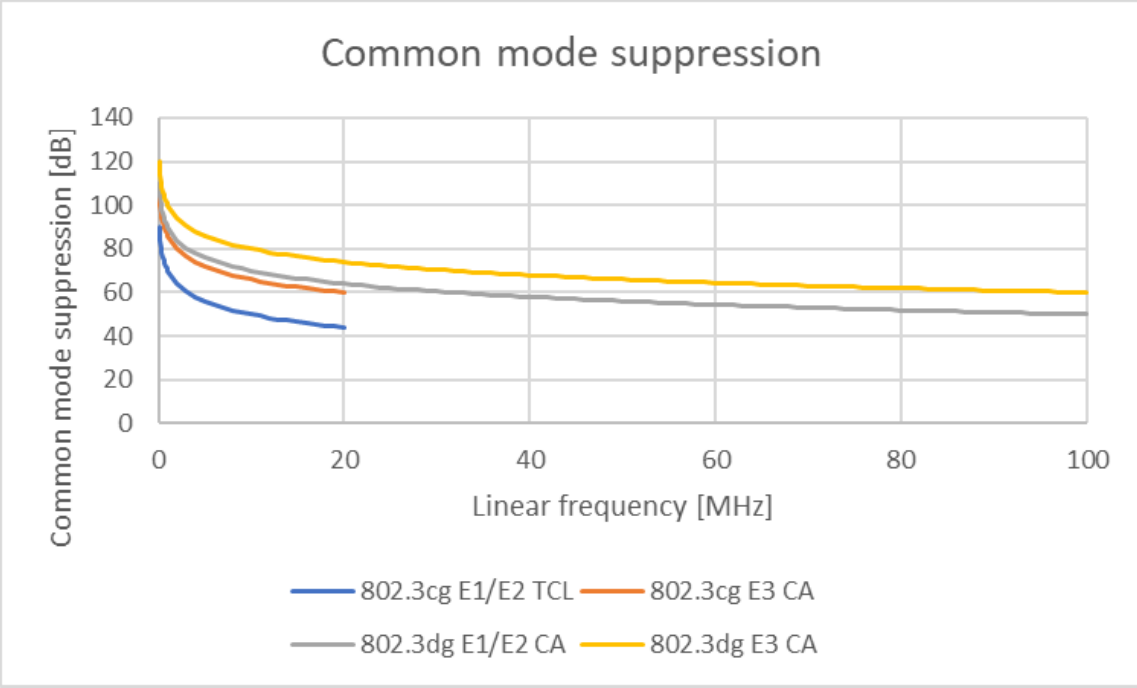
IEEE 802.3cg 10Base-T1L defines coupling attenuation at 50dB for E1 and E2 and 60dB for E3

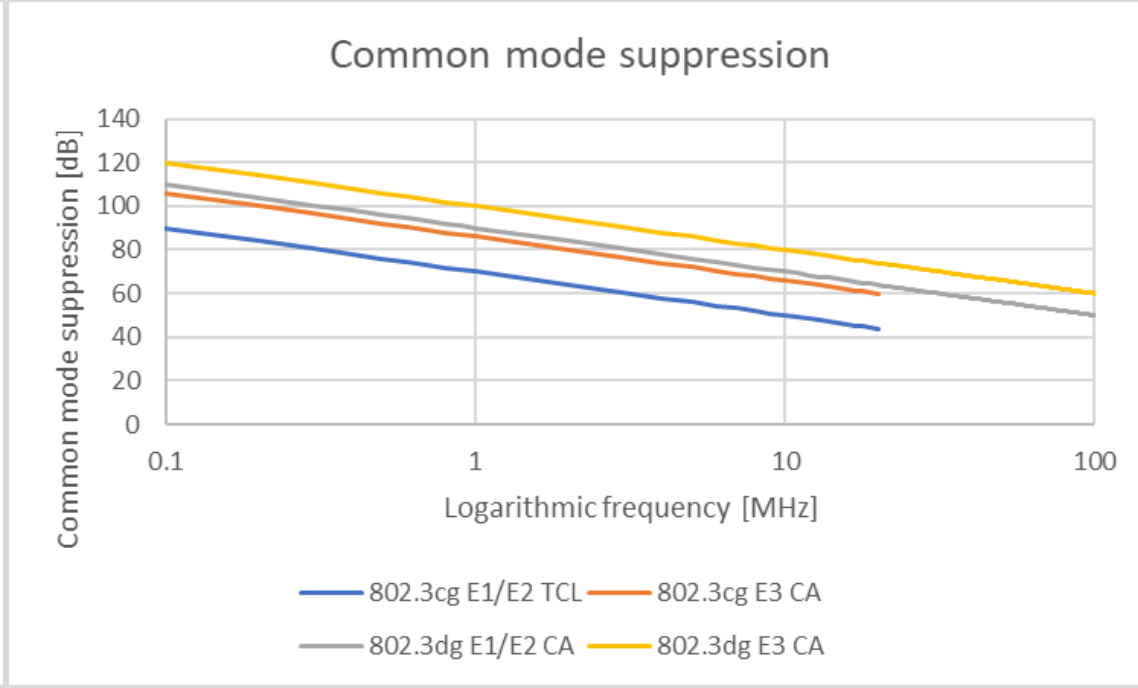
Table 146–6—Coupling attenuation

Frequency (MHz)	(dB)		
	E_1	E_2	E_3
0.1 to 20	≥ 50	≥ 50	≥ 60

Common mode suppression

To achieve similar performance at the maximum frequency for IEEE 802.3dg as for IEEE 802.3cg the requirements have to be improved by at least 20dB to have similar common mode suppression. This would allow only screened links.
802.3cg E1/E2 TCL (blue line): maximum for unscreened links; 802.3cg E3 CA (red line); 802.3dg E1/E2 CA (grey line): lower level for building and process automation; 802.3dg E1/E2 CA (yellow line): requirement for noisy environments (PWM motor drives)





Discussions about building automation

- Discussion partner 1: Siemens
- Discussion partner 2: Airport Munich

What is a must:

Preferred reach 200-250m, maximum 300m

Additional requirements:

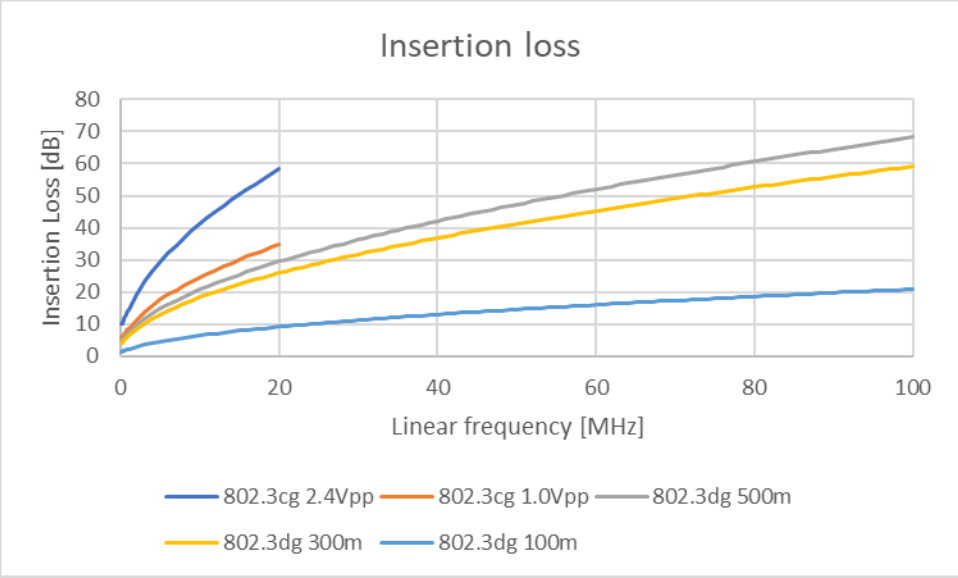
- Building noise environment (E1/E2)
- No latency requirements
- Installed in cable traces and cabinets with other data cables (Alien/ Coupling attenuation)

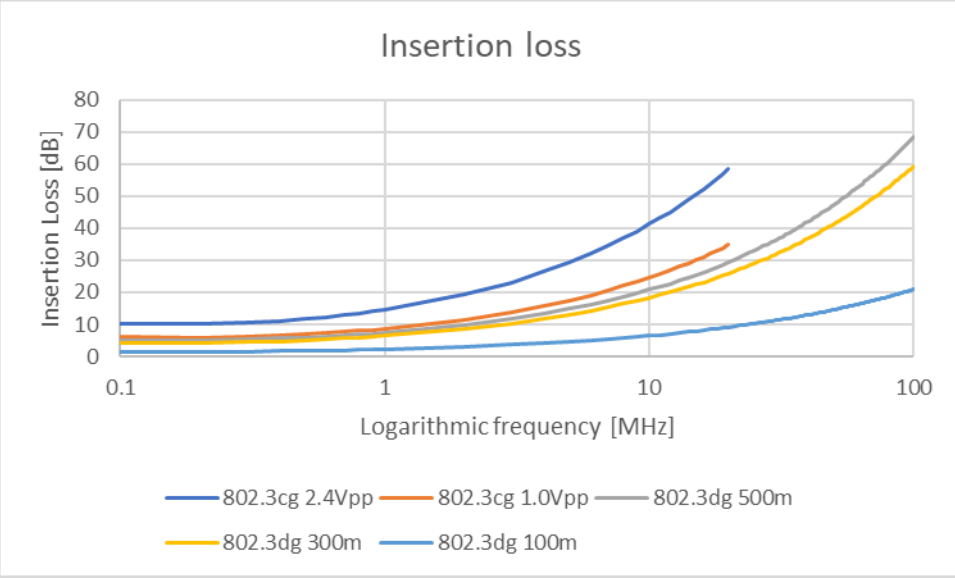
Insertion loss proposals

Till now we see 3 areas for 100Base-T1L:

- Process automation (500m): 5.05*(1.23*SQRT(f) +0.01*f +0.2/SQRT(f)) +5*0.02*SQRT(f)
- Building automation (300m): 3.05*(1.82*SQRT(f) +0.0091*f +0.25/SQRT(f)) +4*0.02*SQRT(f)
- Motor control applications (100m, no FEC): 1.05*(1.82*SQRT(f) +0.0091*f +0.25/SQRT(f)) +4*0.02*SQRT(f)

→ 802.3dg 500m and 300m have a similar attenuation as 802.3cg 2.4Vpp at the maximum frequency, 802.3dg 100m has 21dB@100MHz → 40dB more signal as 802.3dg 300m at 100MHz and 50dB more signal as 802.3dg 500m at 100MHz





Alien crosstalk

Alien Crosstalk cannot be defined yet as first RL and the FEC has to be known to estimate the effective noise level.

Alien crosstalk should be defined to be below the noise of RL with FEC to make sure that by adjacent links and other copper data communication cables nearby no relevant additional noise is coupled into the 802.3dg link.

This can be achieved by an enhanced coupling attenuation requirement of E3 .

graber_3dg_01_08302022 questions:

- PSAFEXT: As it is length dependent use PSAACR-F. The limit line for 10BASE-T1L is not very user friendly.
- Do not degrade the limit lines to reuse installed cables if:
  - Return loss is higher than proposed values
  - and if insertion loss is higher than proposed values.
- Improve connection shielding
- Should we try to match Ex ec and Ex I ? It was developed for kilobyte transmission. Probably a no go (see Graber # 4)